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The impact of foreign direct investment, capital formation and technology on agricultural output in Nigeria

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Abstract
This study looked at how foreign direct investment, capital formation, and technology influence agricultural output in Nigeria. The study made use of the two most often utilized unit root tests, Augmented Dickey-Fuller (ADF) and Philips Perron (PP). In addition, the relationship was established utilizing the Auto Regressive Distributed Lagged ARDL bound test of cointegration. The study's findings revealed a substantial, negative association between foreign direct investment and agricultural output. The use of technology was found to boost agricultural productivity in a favorable manner but statistically insignificant. Furthermore, capital formation and exchange rates have a large and favorable impact on agricultural output. The research suggested that, to attract foreign direct investment (FDI) into Nigeria's agriculture sector, the government must demonstrate a deeper commitment to multi-national investment guarantee organizations. This will not only boost international investors' in agricultural technology trust, but will also soothe their fears of expropriation. The agriculture industry urgently needs to refocus and change its investment patterns.

Keywords: Agricultural output, Capital formation, Foreign direct investment

1. Introduction

Foreign Direct Investment (FDI) is critical to the expansion of the agriculture industry, but it has faced challenges in recent years. The sector's growth has been disappointing, with diminishing investment rates. Foreign direct investment can be beneficial if it focuses on developing and expanding managerial and labor capabilities. Foreign direct investment in Nigeria can not alone lead to sustainable agricultural expansion unless it is accompanied with the necessary structures and infrastructures that can facilitate successful results (Oloyede, 2014). There is low level of participation of foreign direct investment (FDI) into Nigeria's agricultural industry while foreign direct investment (FDI) has a significant and favorable impact on job creation in Nigeria, it has little effect on the Agricultural output (Idowu & Ying, 2013; Owutuamor & Arene, 2018; Ju et al. 2022; Sokunbi, Johnson, Atanda, & Aderemi, 2023). The potential of foreign direct investment (FDI) to accelerate economic growth and integration into the global economy is now well recognized. It has become more significant because the value of concessional aid has decreased and longer-term, more stable funding is now preferred (Danja, 2012). Foreign direct investment (FDI) has historically primarily benefited more developed economies, and they still receive a larger share of FDI globally than developing nations. However, Africa saw the biggest rise in inward investment in 2014, with an announcement of US$87 billion in foreign direct investment (Chakraborty & Nunnenkamp, 2008). Nigeria, with a population of over 200 million, has a vast natural resource base and a sizable market (Iyoboyi, 2019; Ogunnowo, 2022; Anthony-Orji, Orji, Jude, & Ogbuabor, 2023).

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Figure 1 indicates that foreign direct investment net inflows into Nigeria peaked at US$ 8.84 billion in 2011 and fell to negative US$ 0.18 billion in 2022. From the beginning of the study period until around 1983, when it begins to fall until 1994, the trend reveals a fluctuating movement at an increasing rate. When comparing the 1980s and 1990s, to 2000s, the average annual inflow of foreign direct investment into Africa doubled from 2000s to 2009. It also increased considerably between 2010 and 2011. Nigeria's economy has a high demand for goods and services, and it has attracted some foreign direct investment over time.

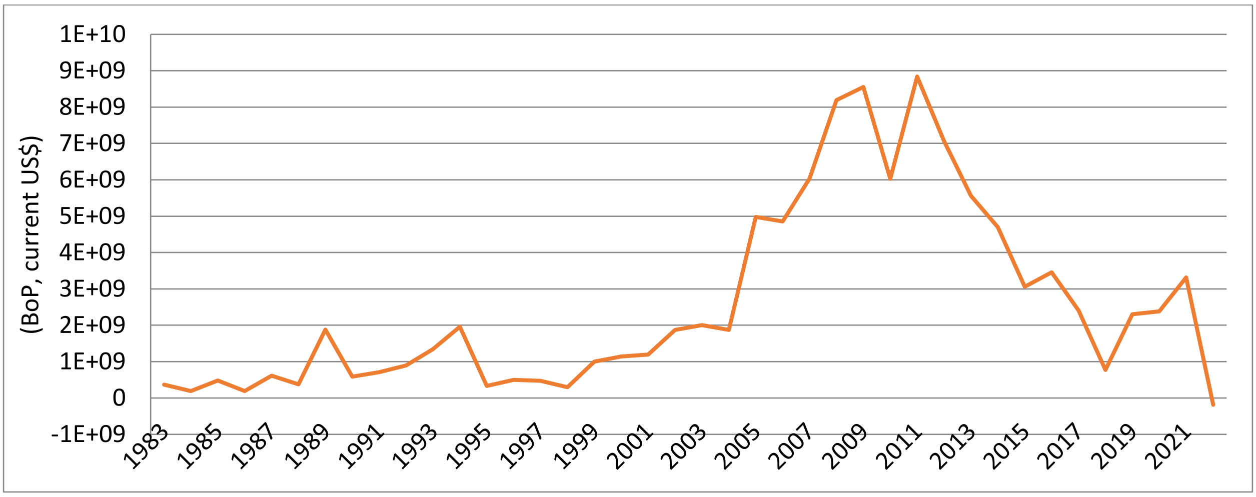

Figure 1 Foreign direct investment, net inflows

However, increased foreign direct investment (FDI) in agriculture may help to bridge the investment gap. The key element restricting productivity in Nigeria's agricultural sector is technology, as technological breakthroughs and innovation are the primary drivers of production. A good educational foundation is required before acquiring technology. Potential foreign investment is apparently impeded by a lack of engineers and technical professionals, notably in Nigeria's agricultural industries (Bala & Baba, 2023). Nigeria withnessed a notable rise in foreign direct investment inflows during the 2000s, with a concentration on the agriculture industry. The agricultural sector has long been disregarded as a catalyst for growth and the fight against poverty, and in many emerging nations, a dearth of public and private investment has led to slower rates of productivity growth and stagnant output. However, by utilizing new technologies, agriculture contributes in a special way to the fight against poverty (Oloyede, 2014; Sikandar, Erokhin, Shu, Rehman, & Ivolga, 2021).

2. Literature Review

There is growing literature on the relationship between foreign direct investment (FDI), capital formation, technology and agricultural output across countries and country specific with vary submission and conclusion. Recently, Bala & Baba (2023) examined the impact of population growth, technological development on food production. The study found that Population growth negatively affects food production, technological development supports a positive relationship with food production. Sabair & Salihu (2011) examined the extents to which FDI influence SME development in Nigeria, Using ordinary least square (OLS). It was discovered that FDI through MNCs has a negative impact on the growth of small and medium-sized businesses in Nigeria. Uwubanmwen & Ogiemudia (2016) applied Philips-Perron unit root tests are to examine the factors that influence foreign direct investment in Nigeria. The factors have a positive correlation, according to the data. The report also recommended that because of its many benefits including technical transfer and innovative management practices FDI be recognized as a key contributor to economic development.

Ajuwon & Ogwumike (2013) used Error Correction Model (ECM) to study the relationship between foreign direct investment in Nigeria's agriculture industry and economic uncertainty. The findings revealed that inflation is the only economic uncertainty variable that has a large but negative impact on short-term foreign direct investment (FDI). While Awe (2013) Used the two-stage least squares method to examine the relationship between foreign direct investment flow and Nigeria's economic growth. The results showed that, as a result of insufficient FDI flow into the Nigerian economy, there is a negative correlation between GDP growth and economic growth. Akinwale, Adekunle, & Obagunwa (2018) examine Nigeria's foreign direct investment and agricultural productivity. Using an error correction model and an enhanced dickey-fuller. The findings revealed that the agricultural sector is unaffected by any macroeconomic indicator, such as government spending, bank loans to the industry, foreign direct investment, or agricultural productivity. Agba (2018) uses an error correction model to estimate the impact of foreign direct investment on Nigerian agricultural output. The findings revealed that foreign direct investment had a minor short-term positive impact on agricultural output but a significant long-run impact.

Zafar, Qin, & Zaidi (2020) employing error correction models, look into how foreign direct investment affects Pakistan's agricultural growth. The results showed that FDI significantly affects crop production index, irrigated agricultural land, fertilizer usage, cereal production land, and agriculture forestry throughout the short and long-run. Makwe & Oladele (2020) used the distributive lag/bound test, the autoregressive test, and the augmented dickey-fuller method to examine the relationship between foreign direct investment and income generation in Nigeria. According to the analysis, there is a small and inverse relationship between corporate income tax and foreign direct investment in agriculture in the short term. Alhaji, Bello, Mohammed, & Attahiru (2022) demonstrated that trade openness had a beneficial short-term impact on economic growth, whereas foreign direct investment had a positive long-run and short-term impact.

3. Methodology

The data sources and model parameters that will be used to analyze the data are provided in this step. The ARDL Bound test is an econometrics methodology used in this research, and econometric tools are used for data analysis. Definitions of the variables and explanations of the employed estimating method are also included.

Model specification

Generally speaking, an economic model's specification is derived from a study carried out by Bala & Baba (2023) utilizing data that is readily available from the study. This could be symbolically expressed as:

$AGO = F(FDI, GCF, EXR, ERD)$............. (1)

In addition to the variables mentioned above, there are others that can influence the dependent variable but are not included in the model. These aspects that are not included in the model are taken into account by introducing an error term or random variable disturbance term to account for all potential disturbances that may affect the model's structure. It is not assumed that economic linkages are correct.

This can be written as:

$AGO_t = \beta_0 + \beta_1 FDI_t + \beta_2 GCF_t + \beta_3 EXR_t + \beta_4 ERD_t + \mu_t$.. (2)

Where:

Agricultural output (AGO), foreign direct investment (FDI), Gross capital formation (GCF), exchange rate (EXR), and Expenditure on research and development (ERD),

β_0 = Constant term

$\beta_1 - \beta_4$ = Coefficients of the explanatory variables
μ_t = Error term
The natural logarithm is then used in equation (2) to enable a more accurate estimate and to directly aid in reducing or eliminating autocorrelation and heteroskedasticity (Gujarati & Bernier, 2004). Another practical method for bringing a highly skewed variable closer to normal is to apply logarithmic adjustments (Benoit, 2011).

$$lnAGO_t = \beta_0 + \beta_1 lnFDI_t + \beta_2 lnGCF_t + \beta_3 lnEXR_t + \beta_4 lnERD_t + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Autoregressive Distributed Lag Test (ARDL)
This study estimates the link between $FDI, GCF, EXR, ERD \; and \; AGO$ using the Autoregressive Distributed Lag (ARDL) bounds test approach to co-integration. Compared to previous co-integration methods, the ARDL approach has a few desirable statistical advantages. The ARDL test procedure yields valid results whether the variables are I(0), I(1), or mutually co-integrated, whereas other co-integration techniques require all the variables to be integrated in the same order. It also produces very efficient and consistent estimates in both small and large sample sizes (Pesaran, Shin, & Smith, 2001). Because all of the series in this study are either I(0) or I(1), this technique consequently becomes pertinent. To define the ARDL model using the variables those were employed in this investigation, namely:

$$\Delta \ln AGO_t = \beta_0 + \sum_{i=1}^{k} \phi_i \Delta \ln AGO_{t-1} + \sum_{i=0}^{k} \varphi_i \Delta \ln FDI_{t-1} + \sum_{i=0}^{k} \phi_i \Delta \ln GCF_{t-1} + \sum_{i=0}^{k} \phi_i \Delta \ln EXR_{t-1} + \sum_{i=0}^{k} \phi_i \Delta \ln ERD_{t-1} + \theta_1 \ln AGO_{t-1} + \theta_2 \ln FDI_{t-1} + \theta_3 \ln GCF_{t-1} + \theta_4 \ln EXR_{t-1} + \theta_5 \ln ERD_{t-1} + \varepsilon_t \ldots\ldots\ldots (4)$$

Where:
Δ = difference operator
θ = long- run are coefficients
ϕ_i = short-run coefficients
ln = logarithms

ARDL Error Correction Term Model
The following is a description of the error correction model used to estimate short-run relationships once long-run relationships have been established:

$$\Delta \ln AGO_t = \beta_0 + \sum_{i=1}^{k} \phi_i \Delta \ln FDI_{t-1} + \sum_{i=0}^{k} \varphi_i \Delta \ln GCF_{t-1} + \sum_{i=0}^{k} \lambda_i \Delta \ln EXR_{t-1} + \sum_{i=0}^{k} \gamma_i \Delta \ln ERD_{t-1} + \gamma ECT_{t-1} \ldots\ldots\ldots (5)$$

Where the ECT in equation 5 is defined as:

$$ECT_t = \ln AGO_t - \alpha_o - \sum_{i=1}^{k} \psi_i \ln AGO_{t-1} - \sum_{i=0}^{k} \varphi_i \ln FDI_{t-1} - \sum_{i=0}^{k} \lambda_i \ln GCF_{t-1} - \sum_{i=o}^{k} \partial_i \ln EXR_{t-1} - \sum_{i=0}^{k} \lambda_i \ln ERD_{t-1} - \varepsilon_t \ldots\ldots\ldots (6)$$

The error correction term (ECT), or long-run residual, reflects how much of the preceding period's disequilibrium is being corrected or adjusted in the current period. Positive coefficients indicate divergence, while negative coefficients suggest convergence. If the ECT estimate is 1, then all of the adjustment occurs inside the interval, or it occurs rapidly and completely. Furthermore, if the estimate of ECT is 0.5, 50% of the adjustment occurs every period or year. Because $ECT = 0$ indicates no adjustment, it is no longer acceptable to establish a long-run relationship. Any short-term disequilibrium between the explained and explanatory variables will converge on the long-run equilibrium, according to a negative and significant ECT_{t-1} coefficient.

Data
Secondary data was used in this investigation. All data for this study, which spanned the years 1983 to 2021, were obtained from the World Development Indicators (WDI) website and Central Bank Statistical Bulletin online publication 2023. The variables used include the exchange rate (EXR), gross capital formation (GCF), foreign direct investment (FDI), expenditure on R&D (ERD), and agricultural output (AGO) as the dependent variable. Where research and development expenses are used as a substitute for technology.

4. Result and Discussion
The conclusion that all variables are steady is amply supported by the results of the unit root test. The data's time series features were first analyzed with the use of test statistics for the augmented Dickey-Fuller (ADF) and Phillips-Perron (PP). The unit root results are displayed in Table 1 every variable is significant at the 1%, 5%, and 10% levels of significance, and every variable is stationary at the level and first difference. ADF is used by ($AGO, FDI, GCF, EXR, and\ ERD$). The results demonstrate level order integration using the Phillips Perron unit root test and the stationary nature of all the variables at first difference, with significance at 1%, 5%, and 10% respectively. The decision is determined by examining the probability values and comparing the absolute values to the relevant ADF statistics. Determining the optimal lag period is critical for avoiding false regression before testing for a cointegration relationship between the variables.

Table 1 Unit root results

	ADF TEST STATISTICS				PP TEST STATISTICS			
	Constant		Trend		Constant		Trend	
Variables	Level	First Difference	Level	First Difference	Level	First Difference	Level	First Difference
AGO	-2.5133 (0.1208)	-6.7157 (0.0000)***	-2.3061 (0.4201)	-7.0112 (0.0000)***	-3.1094 (0.0342)**	-7.7226 (0.0000)***	-2.8131 (0.2016)	-8.9832 (0.0000)***
FDI	-3.2049 (0.0274)**	-3.4540 (0.0158)**	-3.2268 (0.0945)*	-3.7651 (0.0312)**	-3.0362 (0.0405)**	-9.8274 (0.0000)***	-3.0390 (0.1354)*	-14.6418 (0.0000)***
GCF	-2.7580 (0.0740)*	-5.2090 (0.0001)***	-1.8040 (0.6830)	-5.9172 (0.0001)***	-4.1487 (0.0024)***	-5.2090 (0.0001)***	-1.6802 (0.7405)	-5.9672 (0.0000)***
EXR	-0.9518 (0.7593)	-0.9518 (0.7593)	-1.9337 (0.6114)	-0.4825 (0.9794)	-2.0597 (0.2614)	-4.9965 (0.0002)***	-0.0944 (0.9931)	-5.4009 (0.0004)***
ERD	-2.1272 (0.2356)	-7.0999 (0.0001)***	-1.5340 (0.7997)	-7.4685 (0.0001)***	-1.4947 (0.5254)	-7.0522 (0.0001)***	-1.4301 (0.8356)	-7.4685 (0.0001)***

Note: ***1%, **5% and *10% level of significance
Source; (Author's computation using E-views 9 2024)

Table 2 shows that at all significant levels, the calculated F-statistic of 15.8487 is greater than the upper bound critical value. We may safely reject the null hypothesis that there is no cointegration among AGO, FDI, GCF, EXR, and ERD because this suggests a substantial cointegration relationship among the variables. There is a long-run equilibrating link between the variables. The long-run model is estimated once a cointegration relationship between the variables is discovered.

Table 2 Bounds test result

Model	F-statistics	Lag	Level of significance	Bounds critical values Constant(Level) I(0)	I(1)
$AGO = F(, FDI, GCF, EXR, ERD)$	15.8487	4			
			10%	2.45	3.52
			5%	**2.86**	**4.01**
			2.5%	3.25	4.49
			1%	3.74	5.06

Source; (Author's computation using E-views 9 2024)

Table 3 demonstrates that, over time, foreign direct investment (FDI) has a statistically significant negative influence on agricultural output; the likelihood and coefficient values are 0.0043 and 0.1299, respectively. Agricultural output will fall by -0.1299 for every 1% increase in FDI. Gross capital formation ($LGCF$) has a positive and large impact on long-run agricultural output, with a probability value of 0.0050 and a coefficient of 0.1242. The (GCF) will change by 1%, boosting Nigeria's agricultural output by 0.1242 established that, over time, the exchange rate (EXR) has a positive and significant impact on Nigeria's agricultural output. The probability value is 0.0000 and the coefficient is 0.572238. Agriculture output will increase by 0.1242 for each 1% change in the exchange rate.

Moreover, during the study period, agricultural output was positively but statistically insignificantly impacted by research and development ($LERD$) spending. The outcomes support earlier studies' conclusions that foreign direct investment (FDI) negatively affects the dependent variable (Ajuwon & Ogwumike, 2013: Awe, 2013). With an R-squared of 0.9256, the model showed that 92% of the variation in the dependent variable could be explained by the explanatory factors, and only 8% by the error term. The model is well-fitted, as indicated by the Durbin Watson statistic of 2.5099, which also implies that there is no first-order serial correlation in the model because it falls between 1.5 and 2.5.

Table 3 Estimated long-run ARDL cointegration results

	Dependent Variable, InAGO			
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob**
$LFDI$	-0.1299***	0.0398	-3.2626	0.0043
$LGCF$	0.1242***	0.0388	3.1974	0.0050
$LEXR$	0.5722***	0.0675	8.4733	0.0000
$LERD$	0.0337	0.0325	1.0362	0.3138
C	0.5651	0.2903	1.9463	0.0674

Note: ***1%, **5% and *10% level of significance.
Source; (Author's computation using E-views 9 2024)
R-squared=0.925647 DW statistics=2.509910

Table 4 indicates that, in the short run, the probability value is 0.0035 and the coefficient value is 0.0712, indicating a positive and considerable influence of foreign direct investment foreign direct investment (FDI) on agricultural output. Accordingly, an increase of 1% in foreign direct investment will result in an increase of 0.0712 in agricultural output. However, due to its coefficient and probability of -0.1451 and 0.0086, respectively, gross capital formation (GCF) has a short-term negative but considerable impact on agricultural output. To be more precise, a 1% change in (GCF) will result in a short-term drop in agricultural output of -0.1451. In the short term, agricultural output was found to be negatively but statistically significantly impacted by exchange rates (EXR). This is as a result of the short-term coefficient and probability values being -0.5431 and 0.0002, respectively.

Over the course of the study period, spending on research and development has had a positive but negligible effect on agricultural output in the short term, as indicated by the coefficient and probability values of 0.0286 and 0.3021, respectively. The error correction term (ECT) is significant, negative, and has an absolute value less than one. The probability value is 0.0000 and the ECT coefficient is -0.8493. This supports the previous long-run relationship between the series and demonstrates that the first year's rate of adjustment towards the long-run equilibrium is 1%. Because only 1% of the short-term disequilibrium between the explained and the explanatory variables will eventually converge to equilibrium, the pace of adjustment is modest.

Table 4 Error correction term (Short-Run) model results

Dependent Variable, LAGO				
Variables	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
$D(FDI)$	-0.0037	0.0207	-0.1819	0.8577
$D(LFDI(-1))$	0.0712***	0.0212	3.3545	0.0035
$D(LGCF)$	-0.0144	0.0495	-0.2920	0.7736
$D(LGCF(-1))$	-0.1502**	0.0539	-2.7830	0.0123
$D(LGCF(-2))$	-0.1451***	0.0492	-2.9481	0.0086
$D(LGCF(-3))$	0.0958**	0.0403	2.3742	0.0289
$D(LEXR)$	-0.1065	0.1229	-0.8663	0.3977
$D(LEXR(-1))$	-0.2184	0.1307	-1.6701	0.1122
$D(LEXR(-2))$	0.0287	0.1478	0.1941	0.8483
$D(LEXR(-3))$	-0.5431***	0.1187	-4.5746	0.0002
$D(LERD)$	0.0286	0.0269	1.0624	0.3021
$CointEq(-)$	-0.8493***	0.1120	-7.5817	0.0000

Note: ***1%, **5% and *10% level of significance.
Source; (Author's computation using E-views 9 2024)

The diagnostic tests utilized included heteroscedasticity, functional form, serial correlation, and normality. The results of the diagnostic tests in Table 5 demonstrate that the Breusch-Godfrey LM test has a probability value of 0.4043, which is larger than 5% and indicates that the model lacks serial correlation. The Breusch-Pagan Godfrey test for heteroskedasticity had a probability of 0.9777, indicating that the model is homoskedastic. The Jarque-Bera (normality) test returns a probability value of 0.143719, which is greater than 5% and shows that the data in the series is normally distributed, hence it is not significant. The Ramsey RESET test for stability shows that the model is correctly represented, as the probability value of 0.3205 is low.

Table 5 Diagnostic test results

Test Statistics	F(Prob)	Probability
Autocorrelation	F(3,15) = 1.0377	0.4043
Hetroskedasticity	F(16,18) = 0.3585	0.9777
Normality	3.879786	0.1437
Stability	(1, 17) =1.0472	0.3205

The cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests are shown in Figure 2 and are used to determine whether the model stayed stable during the course of the investigation. If, at a 5% level of significance, the residuals line falls inside the straight lines of the crucial bounds, the model is considered stable across the measured period. The fitted area limits are represented by the red lines, and the crucial bounds at the 5% significance level are shown by the blue line. The model is deemed relatively stable as the residual, at the 5% level of significance, falls within the important range.

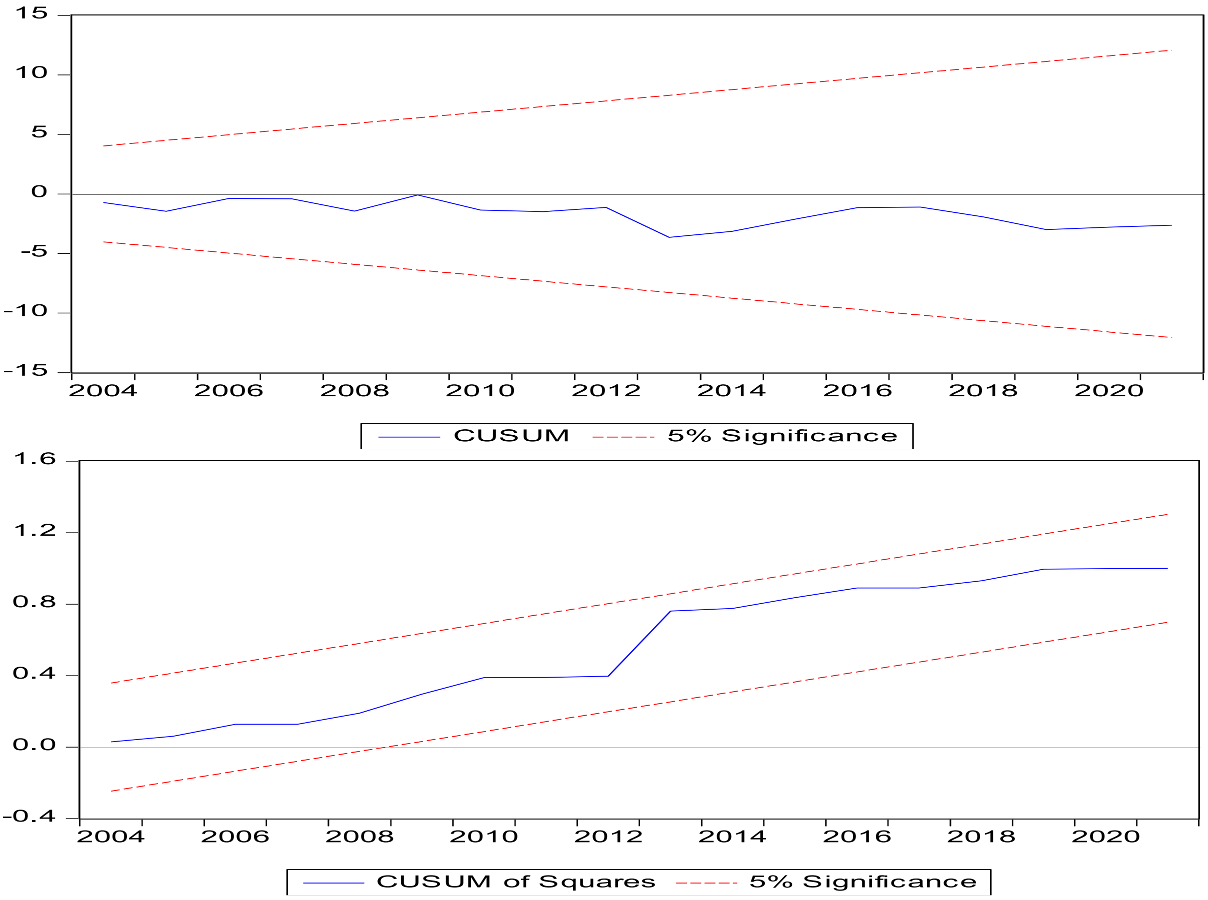

Figure 2 Plot of cumulative sum of squares of recursive residual

5. Conclusion and recommendation

The aim of this study was to examine the impact of foreign direct investment, capital formation and technology on agricultural output in Nigeria. The time series data were used in the study from 1983 to 2021. The Auto Regressive Distributed Lagged ARDL bound test of cointegration method was used to find the co-integration of the variables under study. The findings demonstrated that agricultural output was significantly and negatively impacted by foreign direct investment (FDI).

Agricultural output was positively and significantly impacted by gross capital formation (GCF). The agricultural output was positively and significantly impacted by the exchange rate (EXR). Lastly, expenditure research and development (ERD) had a positive but insignificant effect on agricultural output in Nigeria.

Based on its findings, the study concluded that there is a positive and significant relationship between agricultural output, gross capital formation, and the exchange rate. However, there is a strong negative association between agricultural output and foreign direct investment. Furthermore, research and development spending was found to have a small but positive effect on agricultural output. While research and development expenditures did not confirm, the data on foreign direct investment, gross capital formation, and exchange rates all corroborated the a priori forecast. In conclusion, the exchange rate and gross capital formation have a significant and positive impact on agricultural output. The study recommended that, to attract foreign direct investment (FDI) into Nigeria's agriculture sector, the government must demonstrate a deeper commitment to multi-national investment guarantee organizations. This will not only boost international investors' trust, but will also soothe their fears of expropriation. More crucially, the farm sector must reshape its revenue and investment strategies.

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